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The Utilization of Nehu, Stolephorus purpureus: A Potential
Conflict Among User Groups

By

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INTRODUCTION

The nehu, Stolephorus purpureus, a small (40-60 mm), fragile anchovy that schools in bays and harbors, is the most important native bait fish found in the Hawaiian Islands. The Hawaiian aku or skipjack tuna, Katsuwonus pelamis, pole-and-line fishery is entirely dependent on a supply of live bait and nehu accounts for about 92% of the bait utilization of this fishery (Yamashita, 1958). Although the nehu possesses most of the qualities of a good baitfish, there are some major problems associated with its use, among them being its short supply, particularly during the peak skipjack tuna fishing season from May to September. Indeed, one of the major factors limiting the development of the Hawaiian aku fishery to its full potential is the supply of live bait.

The commercial aku fishery is, by far, the largest user group of the nehu in Hawaii. Over the years, various researchers have attempted to put a value on nehu relative to the commercial

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aku fishery. Most recently, Yamauchi and Afifi (in press) imputed a dollar value of the nehu bait fishery in Kaneohe Bay, one of the major baiting sites in the Hawaiian Islands, ranging from \$350,000 to \$660,000 annually. Since Kaneohe Bay on the average accounts for about one fourth of the total nehu production of the State, the total State value of the bait fishery for nehu would be four times that of Kaneohe Bay or from \$1,400,000 to \$2,640,000. By comparison, figures published by the Hawaii State Division of Fish and Game show that the commercial fish landings in Hawaii in 1972 were valued at \$5,747,103.

Other user groups of nehu are recreational fishermen, who use nehu as bait for sport fishing, takers of nehu for "family consumption," and commercial fishermen who use nehu to catch fish other than skipjack tuna. All these users of nehu, in contrast to the commercial aku fishery, do not require that the nehu be alive and their total requirement probably constitutes only a small percentage of the total utilization of nehu.

It would be well here to review briefly what the laws and regulations of the State of Hawaii provide with regard to the nehu. The regulations of the Division of Fish and Game of the Department of Land and Natural Resources provide that bait permits be issued to commercial fishermen for the taking of certain fishes, including the nehu. The regulations further state that, "bait permits shall be issued to persons engaged in catching bait fish for use as bait in fishing operations where

the fish caught are landed in the State and no baitfish caught under a bait license shall be sold or transferred except for such purpose." Furthermore, "it shall be unlawful to take nehu for commercial bait purposes except by permit issued by the Division of Fish and Game of the Department of Land and Natural Resources," and "all persons holding bait permits shall file catch reports with the Division of Fish and Game." However, "all persons may take nehu for family consumption, provided, however, that only one gallon per person per day may be taken and no net longer than twenty-five feet may be used." The term "family consumption" is defined as "the taking of nehu for any purpose other than for use as bait by a licensed commercial fisherman." Thus, the takers of nehu for family consumption require no bait permit. Finally, it is unlawful at anytime to sell, offer for sale, or trade dried or cured nehu.

THE PROBLEM

Nehu has probably been used as bait to catch aku since the very beginning of the fishery. Cobb (1903) gives an account of the techniques used by the native Hawaiians for catching aku, including the practice of the use of nehu as live bait. Because of the long tradition of the use of nehu as bait, the local aku fishermen have come to view the nehu resource in a proprietary manner and resent the intrusion of other user groups. Recently, there apparently has been an increase in the number and types of

user groups, including groups allegedly catching and illegally selling nehu. An associated problem is that these user groups roil the waters and scatter the nehu while catching bait, thus making it difficult for the aku fishermen to catch bait. This problem is apparently most acute in Kaneohe Bay, Oahu where the aku fishermen have complained about certain other user groups of taking "considerable amounts" of nehu.

Because of the increased number of different user groups and an apparent increased demand on the nehu resource, there is a need for an updated study to determine if the present utilization of nehu exceeds levels considered good for proper management. The results of this study should determine if there is a need to develop a suitable management scheme. Regardless of the status of the nehu resource, there is a problem now with a potential conflict among the various user groups. The purpose of this report, then, is to present some options to the solution of the problem of the potentially critical conflict among user groups so that the highest and best utilization of the nehu resource can be realized, and to review rather superficially the status of the nehu resource.

THE NEHU RESOURCE

. 1 The nehu is generally found in certain brackish, turbid inshore waters of most of the major islands in Hawaii and their relative abundance in various localities is limited by the presence of suitable environmental conditions. The annual total State catch of nehu from 1948 to 1972 is shown in Figure 1. During this period the annual catch of nehu fluctuated from a low of 23,622 buckets² to a high of 49,712 buckets and averaged 36,195 buckets. There appeared to be no clear trends, upward or downward, in the catches. In Figure 1 are also shown the number of active aku boats and the CPUE (catch per unit of effort) of nehu, in terms of catch per boat from 1948 to 1972. It can be seen that the number of aku boats in the State declined from 1955 to 1972. The CPUE for nehu, however, showed a generally increasing trend during the same period. Therefore, it appears that although the number of boats was declining, the individual boats were able to catch more nehu so that no declining trend in total catches were evident. It should be pointed out, however, that there is some evidence to suggest that the nehu in the different baiting sites throughout Hawaii comprise discrete subpopulations and do not intermingle to any great degree (Tester and Hiatt, 1952). Therefore the total State catch of nehu may not reflect the true condition of the nehu populations in the various baiting sites.

The relative importance of the islands of Oahu, Maui, Hawaii, and Kauai in terms of nehu production from 1948 to 1972

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is shown in Table 1. It can be seen that, by far, Oahu was the most important bait producer among the four islands. The reason for this is most likely because of the greater availability of habitats suitable for nehu on Oahu. Between 1948 and 1972, 41% to 90% (mean of 68%) of the nehu catches by aku fishermen were made on Oahu. In the last 7 years (1966 to 1972) 83% to 90% (mean of 87%) of the catches were made on Oahu. It appears that in more recent years the aku fishermen have come to rely more on the bait supply on Oahu than on the neighboring islands. One contributing factor to the small amount of nehu presently being taken on the other islands is the fact that the number of boats based on these islands, which has always been small, is at present even smaller (see Table 1). In order of relative importance Maui follows Oahu, then Hawaii and lastly Kauai. Principal baiting sites on Maui are Maalaea Bay and Kahului Harbor; on Hawaii, Hilo Harbor and Kawaihae Harbor. The small amounts of nehu produced on Kauai are taken mostly at Nawiliwili and Hanapepe.

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Because of the importance of the island of Oahu in the total State production of nehu, it is well to consider the status of the nehu resource on Oahu in greater detail. Table 2 shows the relative importance of the various baiting sites on the island of Oahu from 1948 to 1972. By far the most important baiting sites were Kaneohe Bay and Pearl Harbor. During the period from 1948 to 1972 Kaneohe Bay and Pearl Harbor produced, on an average,

78% of the nehu caught by the aku fishermen on Oahu. All the rest of baiting sites combined produced 22%. It can be seen in Table 2, however, that the fraction of the annual total Oahu production of nehu contributed by any of the various baiting sites experienced wide fluctuations during this period. For example, the annual fraction produced by Kaneohe Bay from 1948 to 1972 varied from 13% to 84% of the Oahu total. The interrelationships of these annual fluctuations within a particular baiting site and among the various other sites are probably complex and will not be discussed here.

The annual catches of nehu from 1948 to 1972 in Pearl Harbor and Kaneohe Bay are shown in Figure 2. Bachman (1963) noted a periodicity in the relative abundance of nehu on Oahu during the period from 1948 to 1960. He noticed a peak in relative abundance every 2 or 3 years. The annual catch of nehu between 1960 and 1972 also showed some sort of cycle in abundance, particularly in Pearl Harbor. The important point here is that there seems to be no declining trend in the catches of nehu in Pearl Harbor and Kaneohe Bay over the years. However, the large catches of nehu made in Pearl Harbor in 1971 and 1972 should be of some concern. Bachman (1963), using the Schaefer (1957) method, determined that the maximum sustained yield of nehu in Pearl Harbor was 18,620 buckets with an effort of 691.5 boat days. In 1971, the catch of nehu in Pearl Harbor was 18,834 buckets with 687 days of effort (R. N. Uchida, Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96812, pers.

comm.) It should be pointed out here that whether Bachman's "boat-days" is comparable with the effort in terms of "days" is not known.

The situation in Kaneohe Bay is somewhat different from that in Pearl Harbor. Bachman (1963) found that Schaefer's (1957) method could not be used to determine the maximum sustained yield of nehu in Kaneohe Bay because there was a "population resiliency" within the fishery, and up to the time of his study, enough effort had not been expended to make a difference in the nehu population. The annual catch statistics shown in Figure 2 do not indicate any serious problems with the nehu population in Kaneohe Bay at present.

Up to this point the nehu resource has been discussed primarily as it relates to the commercial aku fishery. As noted earlier, however, there are other user groups utilizing the nehu resource. These other user groups apparently restrict their nehu catching activities primarily to Kaneohe Bay on Oahu. One reason for this is because of Kaneohe Bay's easy accessibility to all user groups. Indeed, Kaneohe Bay is one of the more popular recreational areas on Oahu and a large number of different activities are carried out in its waters (Yamauchi and Rutherford, in press).

For resource management purposes it would be useful to determine the total catch of nehu, including those catches made by the other user groups. It is difficult, however, to document

the catches of nehu made by the other user groups. It was noted earlier that a license was not required for takers of nehu for family consumption, and these non-licensed users were not required to submit catch reports. Takers of nehu for family consumption presumably include people catching nehu for table food and recreational fishermen who use nehu as bait in sport fishing.

Some data are available for commercial fishermen other than aku fishermen who catch nehu for use as bait. These fishermen fish the inshore waters with handlines for fish such as omaka, Caranx mate, hahalalu, Trachurops crumenophthalmus, opelu, Decapterus pinnulatus, and weke, Mulloidichthys samoensis. Statistics compiled by the Hawaii Division of Fish and Game show that these fishermen took 553 buckets of nehu from January to November of 1973. The mean annual catch of nehu made by the aku fishermen in Kaneohe Bay from 1948 to 1972 was 10,472 buckets. Thus, in the 11-month period of 1973 the other commercial fishermen took approximately 5% as much bait taken annually, on the average, by the aku fishermen.

Although the nehu catch statistics for Kaneohe Bay are incomplete in that they do not include the catches of all the user groups, it appears that, superficially, the nehu population is not in bad condition. That is, if the nehu population was in distress, this condition should be indicated in the catches made by the aku fishermen. As noted earlier, Bachman (1963) suggested that the nehu in Kaneohe Bay (up to 1960) had a "population resilience" and that fluctuations in apparent abundance were not

fishery related. More recent data indicate that the fishing pressure, including that of other user groups, still has not made a marked effect on the nehu population in Kaneohe Bay.

There is still a need, however, to update Bachman's (1963) study. The fact that the catch of nehu in Pearl Harbor in 1971 and 1972 exceeded or came close to the maximum sustained yield, as determined by Bachman, should be of some concern. The accuracy of Bachman's estimate should be evaluated. The maximum sustained yield of nehu in Kaneohe Bay should also be determined. Finally, further studies on the interrelationships of the nehu populations in the various baiting sites throughout the State should be instituted. The results of this study should have important implications in the management of this valuable resource.

POSSIBLE SOLUTION TO THE PROBLEM OF USER CONFLICTS

Any possible solution to the problem of user conflicts must consider the viewpoints and demands of all the user groups. Should regulations and laws governing the utilization of the nehu be promulgated based purely on economic considerations or are other less well-defined values just as important? That is, how does one determine which user group has the greater vested interest in the nehu resource. This is difficult to determine even on a purely economic basis. It has been pointed out that the value of the nehu resource has been estimated at \$1,400,000 to \$2,640,000 to the commercial aku fishermen. Comparable figures for commercial fishermen other than aku fishermen are not available. These handline

fishermen use nehu as bait to catch hahalalu, omaka, opelu, and weke. The quantity of nehu used by these fishermen is not known. However, the value of the landings of these species landed by the handline fishermen amounted to about \$116,912 in 1972. With information on all the necessary variables, economists could probably impute values on nehu to these fishermen also.

The value of nehu to those who catch nehu for table food is even harder to determine, one reason being that no catch statistics are available for this user group. The monetary value of the catch, however, is probably minimal.

Similar to the other user groups, catch figures of nehu for recreational fishermen are not readily available. It would be useful to determine the quantity of nehu utilized by recreational fishermen on which economists could impute values. Although the amount spent for all bait may not be great the total expenditure by recreational fishermen to pursue their hobby appears to be considerable. Hoffman and Yamauchi (1972) studied recreational fishing in Hawaii and stated that while no purposeful comparisons of recreational and commercial fishing was attempted, "all indications point to the confirmation of the feelings of many including the members of the 1967 Governor's Marine Advisory Panel, that the recreational fishing sector provides greater benefits to Hawaii than the commercial fishing sector."

Another factor to consider in the solution of the problem is that there is a need to institute management measures to regulate the taking of nehu so that more efficient use is made of this valuable resource. For example, the following situation should be considered. The aku fishermen spend considerable time searching for and catching nehu needed to fish aku. This is valuable time which could be more profitably put to use fishing for aku. The baiting operations are made more difficult and take considerably more time when other user groups roil the water and scatter the nehu. The problem becomes more serious during the peak aku season from May to September when the demand for bait increases and the aku boats must compete not only with each other for bait but with these other user groups. Another important point to consider is that the aku fishery requires live bait whereas for all the other user groups live nehu is not a requirement.

What are some of the options in solving the problem of conflicts among user groups and at the same time provide for the highest and best utilization of the nehu resource? Several options are suggested below. These options are not mutually exclusive. Perhaps a combination of two or three of those suggested may work to solve the problem.

One option would be to raise the fee for a bait permit high enough to discourage "spurious" users of nehu. This should eliminate those commercial fishermen who do not really need nehu

but use it because it is available. This action, however, will not exclude the other user groups like the takers of nehu for family consumption and recreational fishermen since no permit is required of these user groups. Thus, the problem of the roiling of the water and the scattering of nehu schools would not be solved.

Setting catch limitations for the other user groups (family consumption, recreational fishermen and other commercial non-aku fishermen) may prevent "excessive" amounts of bait to be taken by these groups but again will not solve the "roiling" and "scattering" problems. Then, too, this may not be equitable to these groups.

Restricting the privilege of catching nehu exclusively to aku fishermen either throughout the entire year or during May to September when the need for nehu by the aku fishery is greatest will presumably solve the aku fishermen's problems. However, this option will not make the highest and best use of the nehu because other user groups will not have access to nehu during part or all of the year.

An option that perhaps will be acceptable to all user groups would be one that will allow only the aku fishermen to catch nehu together with some stringent stipulations on the aku fishermen. These stipulations would be that for the exclusive privilege of catching nehu the aku fishermen will be required to save and preserve by salting all the nehu that die during

their baiting and fishing operations. Furthermore, that the salted nehu would be made available, perhaps through some middle men, at nominal cost and at convenient outlets to all users. Also, there should be a guarantee that the other user groups will have access to a certain amount of nehu on an annual or some other basis.

e 3 This option will eliminate the "roiling" and "scattering" problem and still make nehu available to all user groups. It also has other benefits. Table 3 shows the amount of nehu caught and the amount actually used in fishing operations by the aku fishermen from 1963 to 1972. The difference between the amount caught and used is presumed to be the quantity of nehu that die and are discarded by the aku fishermen. During this 10-year period the amount of nehu that died and was discarded amounted to an average of 30% of the amount that was caught, or an average of 10,199 buckets. It could well be that 10,199 buckets ^{32.4 metric tons or} (71,393 pounds) of nehu may fulfill the needs of all the other user groups. The nominal amount charged for the bait should defray the operating costs of maintaining this system. And good use will be made of the nehu that are now usually discarded.

The recreational fishermen will probably be happy to pay a nominal sum for salted nehu to use as bait. The commercial fishermen (other than aku fishermen) should also be agreeable to purchasing nehu. This will eliminate valuable time spent catching

their own bait--time that could be more profitably put to use catching income-producing fish. And users of nehu for table food would most likely be willing to pay a nominal price for nehu.

In summary, the solution to the problem of conflicts among user groups must incorporate provisions for the highest, best, and most efficient use of the valuable nehu resource. It would appear, then, that the aku fishermen should be allowed to catch nehu without the interference of the other user groups. This should make their operations more efficient by reducing time spent baiting. By the same token, all the nehu that are not utilized by the aku fishermen after being caught, i.e., all the bait that die during baiting and fishing operations, should be saved for the utilization of the other user groups. These actions will maximize the operating efficiency of the aku fishery and other user groups and also make better utilization of the nehu resource for all the user groups.

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Table 1.--Relative Importance of Oahu, Maui, Hawaii, and Kauai in nehu production, 1948-72.

(Based on data from Hawaii Division of Fish & Game.)

Year	Oahu			Maui			Hawaii			Kauai		
	No. of boats	Fraction of State catch	No. of boats	No. of boats	Fraction of State catch	No. of boats	No. of boats	Fraction of State catch	No. of boats	No. of boats	Fraction of State catch	No. of boats
1948	18	0.57	5	0.28	2	0.12	--	0.03	--	--	0.03	--
1949	20	0.70	4	0.19	2	0.10	--	0.00	--	--	0.00	--
1950	18	0.61	5	0.30	2	0.08	2	0.01	2	2	0.01	2
1951	19	0.49	5	0.32	2	0.16	2	0.03	2	2	0.03	2
1952	19	0.51	5	0.29	2	0.17	2	0.03	2	2	0.03	2
1953	19	0.59	5	0.27	2	0.10	2	0.04	1	1	0.04	1
1954	18	0.49	4	0.24	3	0.22	3	0.05	2	2	0.05	2
1955	21	0.52	4	0.27	3	0.19	3	0.02	--	--	0.02	--
1956	20	0.65	4	0.21	2	0.13	2	0.01	--	--	0.01	--
1957	19	0.70	4	0.15	2	0.15	2	0.00	--	--	0.00	--
1958	16	0.65	6	0.18	2	0.15	2	0.01	--	--	0.01	--
1959	15	0.41	6	0.36	2	0.21	2	0.02	--	--	0.02	--
1960	12	0.57	7	0.23	2	0.15	2	0.04	--	--	0.04	--
1961	12	0.61	7	0.22	2	0.15	2	0.01	--	--	0.01	--

Table 1.--Continued.

1962	12	0.63	5	0.21	3	0.14	--	0.02
1963	12	0.69	5	0.20	3	0.11	--	0.00
1964	12	0.78	5	0.10	3	0.11	--	0.00
1965	14	0.77	2	0.09	3	0.13	--	0.00
1966	13	0.87	2	0.07	2	0.06	--	0.00
1967	14	0.87	2	0.07	2	0.06	--	0.00
1968	12	0.89	2	0.06	2	0.04	--	0.00
1969	12	0.88	2	0.10	1	0.02	--	0.01
1970	12	0.87	2	0.10	1	0.03	--	0.00
1971	11	0.83	2	0.14	1	0.04	--	0.00
1972	12	0.90	2	0.08	1	0.02	--	0.01
25-year mean		0.68		0.19		0.12		
(1948-72)								0.00
Last 7-year		0.87		0.09		0.04		
mean (1966-72)								

Table 2.--Relative importance of various baiting sites on Oahu, 1948-72.
(Based on data from Hawaii Division of Fish & Game.)

Year	Fraction of total Oahu catch					Total Oahu catch (buckets)
	Kaneohe Bay	Honolulu Harbor	Keeki Lagoon	Pearl Harbor	Other areas	
1948	0.84	0.01	0.01	0.07	0.08	23,988
1949	0.58	0.04	0.02	0.34	0.02	27,660
1950	0.50	0.26	0.03	0.18	0.03	24,160
1951	0.52	0.18	0.03	0.25	0.01	19,901
1952	0.35	0.13	0.06	0.44	0.02	15,150
1953	0.40	0.16	0.05	0.35	0.03	21,997
1954	0.54	0.14	0.06	0.23	0.02	21,320
1955	0.48	0.09	0.04	0.35	0.04	25,775
1956	0.48	0.07	0.14	0.27	0.04	26,582
1957	0.25	0.11	0.09	0.54	0.01	21,407
1958	0.41	0.11	0.08	0.37	0.03	21,799
1959	0.29	0.20	0.17	0.30	0.04	15,615
1960	0.49	0.02	0.19	0.26	0.03	13,648
1961	0.40	0.10	0.08	0.30	0.12	22,872

Table 2.--Continued.

1962	0.32	0.10	0.16	0.31	0.11	21,707
1963	0.35	0.07	0.17	0.35	0.05	22,674
1964	0.13	0.11	0.27	0.43	0.06	25,131
1965	0.19	0.12	0.22	0.45	0.02	28,131
1966	0.45	0.08	0.21	0.24	0.02	27,500
1967	0.42	0.09	0.19	0.30	0.00	27,732
1968	0.49	0.03	0.07	0.38	0.03	31,755
1969	0.45	0.04	0.07	0.42	0.01	26,642
1970	0.56	0.04	0.07	0.33	0.01	29,003
1971	0.34	0.04	0.05	0.54	0.02	34,699
1972	0.41	0.01	0.05	0.52	0.01	35,216
25-year mean	0.43	0.09	0.10	0.35	0.03	
(1948-72)						
Last 7-year	0.44	0.05	0.10	0.40	0.02	
mean (1966-72)						

Table 3.--Utilization of nehu by the aku fishery.

(Data from Hawaii Division of Fish & Game.)

Year	Caught	Used	Mortality (caught-used)	Percent mortality
1963	32,787	23,628	9,159	27.9
1964	31,981	23,694	8,287	25.9
1965	36,384	28,315	8,069	22.2
1966	31,614	23,466	8,148	25.8
1967	31,932	21,264	10,668	29.7
1968	35,524	23,911	11,613	32.7
1969	29,721	18,833	10,888	36.6
1970	33,451	22,130	11,321	33.8
1971	41,928	30,691	11,237	26.8
1972	39,273	26,674	12,599	32.1
Total	344,595	242,606	101,989	
Mean	34,460	24,261	10,199	29.6

TEXT FOOTNOTE

²A bucket of bait is roughly equivalent to 7 pounds.

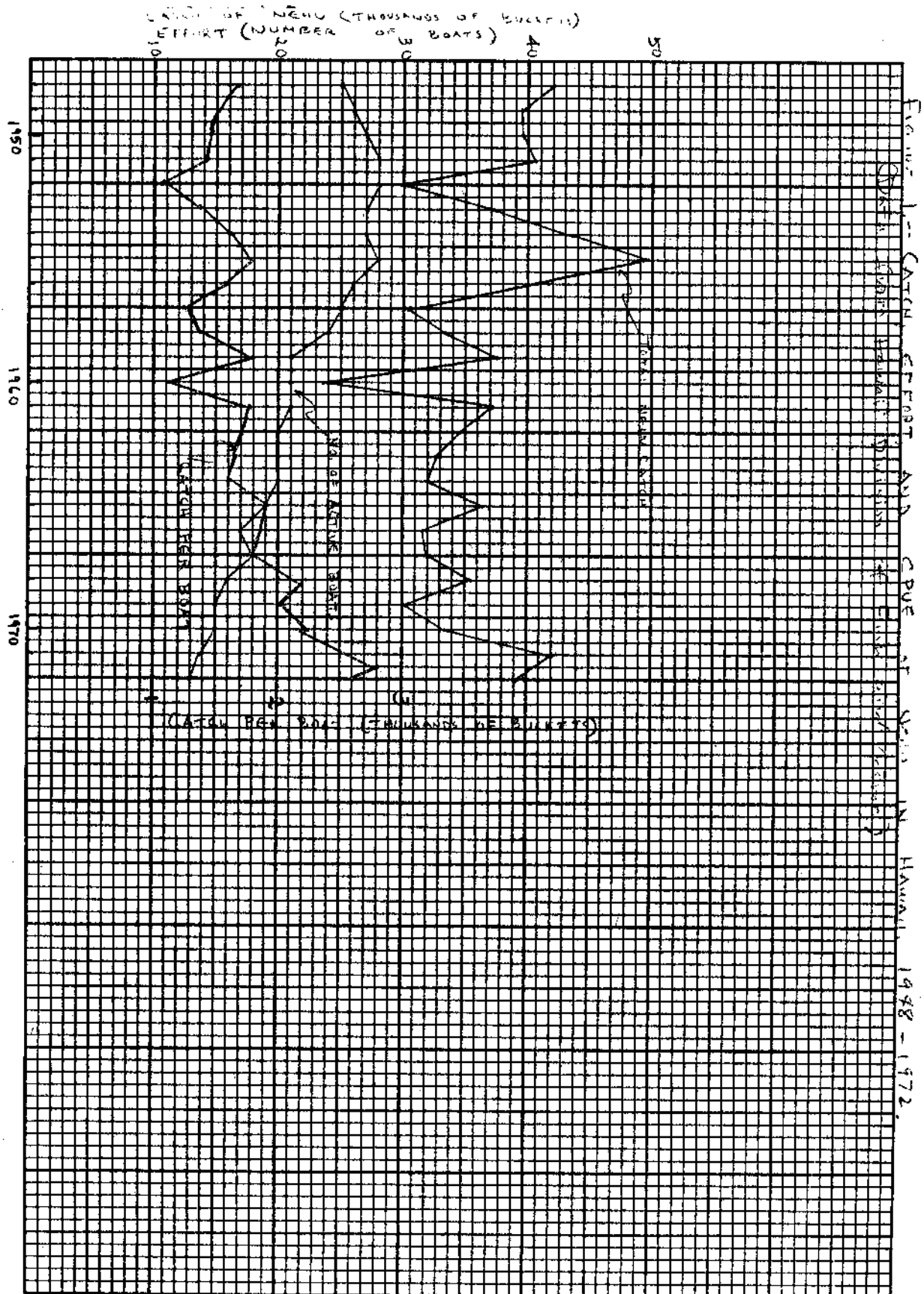


Figure 2--

CATCH OF NEAL

OF FISH (continued)

AND KANEHOE BAY

1942-1972

(Data from Hawaiian Division)

SEASON 1942-1972

THOUSANDS OF FISHES

